旱作水稻根系在不同土層吸水量的品種間差異(預報)

吳振能・藍　調

一、前　言

水稻的栽培，原以灌溉方便的水田爲限。在缺水地區以普通方法栽培水稻時，因未能充份灌漑，即不能適應。但以水稻的旱地栽培方法，則可改善不少。因此爲便於將來推廣這種栽培方法，首先對於旱作水稻的吸水特性宜加研究，然後針對其吸水特性調節灌漑方法，以提高產量，使缺水地區栽培水稻的困難得以解除。

旱作灌漑的原則之一是當灌漑時務使水分滲透土中根系分佈範圍，但不致發生重力水而流失。然而旱作水稻根系的分佈情形及其從不同土層吸收水量的差別（所謂吸水型）如何，又其品種間的差異都尙待研究。

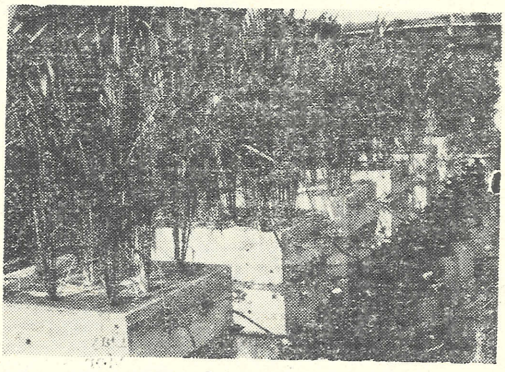
本報告係此一研究的初步結果。其他各方面的有關問題的研究，尙在進行中。

二、研究方法

本研究在玻璃室進行，但除颱風來襲時外，經常開放門窗，只留防蟲紗網，且於晴天高溫時以抽風機調節室溫，使之接近自然狀態。

供試品種：第一期作爲臺農選１號、臺農選３號及臺中186號。第二期作用臺中186號、臺中65號及嘉南２號。

不同土層的吸水量乃以三層式自動灌水裝置，每天上午九時以各層貯水瓶的消耗水量，分別測定之。



照片１：旱作水稻在不同土層吸水量的研究實況

The real sight of water absorption measurement with auto-irrigators for lowland rice cultivated on upland

其裝置的平面爲60×60公分，各層的深度是20公分。各層中央埋設石膏電極一個，並將電線導出外面，以便測定土壤含水量。每一裝置組成後，調節其土壤含水量爲最大容水量的75～80%（旱田狀態）而進行研究。每套裝置的底部，內側及上層土面都舖蓋塑膠布；土面的塑膠布乃於稻種發芽後打洞，使其伸出外面，其後隨著稻株的發育而剪大洞徑，必要時以化學纖維堵塞空隙，盡量防止水分的發散。

每品種用上述裝置兩套，重複２次；每套播種９穴，待發芽後每穴留一健苗，以栽培９株水稻，如照片１所示。

不同土層根系的分佈量乃於收穫時，將裝置按層解開，細心檢取各層的稻根，待風乾後測定。

在玻璃室內設置百孔箱，內裝各種溫度計，每

天按時觀測最高及最低氣溫與空氣的相對濕度，以及天氣概況等，以資考察水量的變化受氣象因子的影響情形。

另一方面，每十天調查水稻株高、分蘗數及生葉數等，以便查考每一貯水瓶消耗水量的正確性。

三、研究結果

本研究供試水稻第一期作於民國58年3月28日播種於實驗裝置，而於同年7月16日結束，其時臺農選1號及臺中186號為出穗期間，但臺農選3號尚未出穗。第二期作於 58年8月4日播種，至59年1月 4 日結束（成熟期）。第二期作，因受9月27日艾爾西颱風的影響，平均氣溫也降低了 5°C。因此自9月27日至10月6日之間，上層（0～20cm）的吸水量減低。然因此一時期為水稻發育中期，植株不久即行恢復，故就全期而言，其影響並不甚大。

玆將初步結果概述於下：

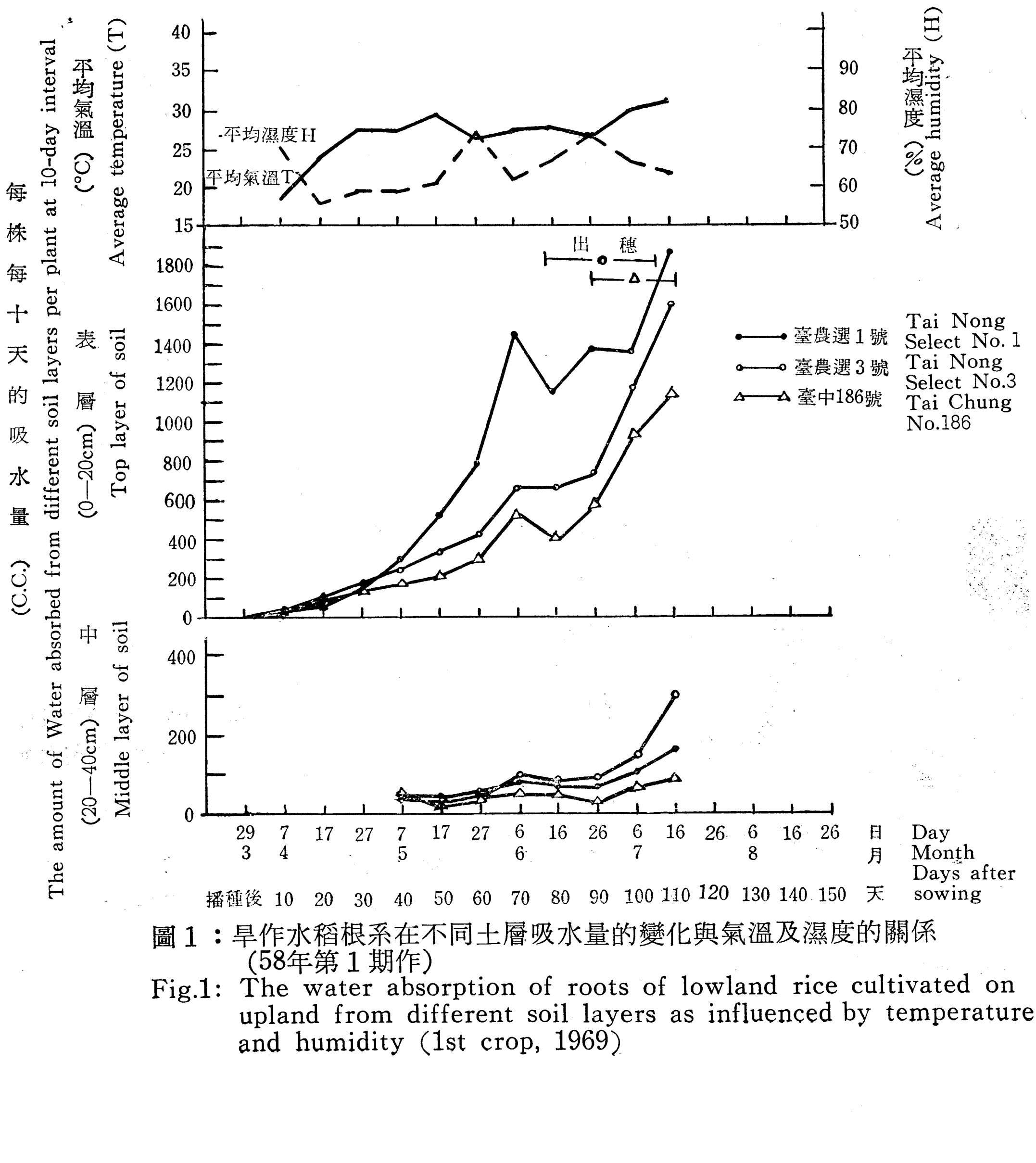


圖1：旱作水稻根系在不同土層吸水量的變化與氣溫及濕度的關係（58年第1期作）

Fig.1: The water absorption of roots of lowland rice cultivated on upland from different soil layers as influenced by temperature and humidity (1st crop, 1969)

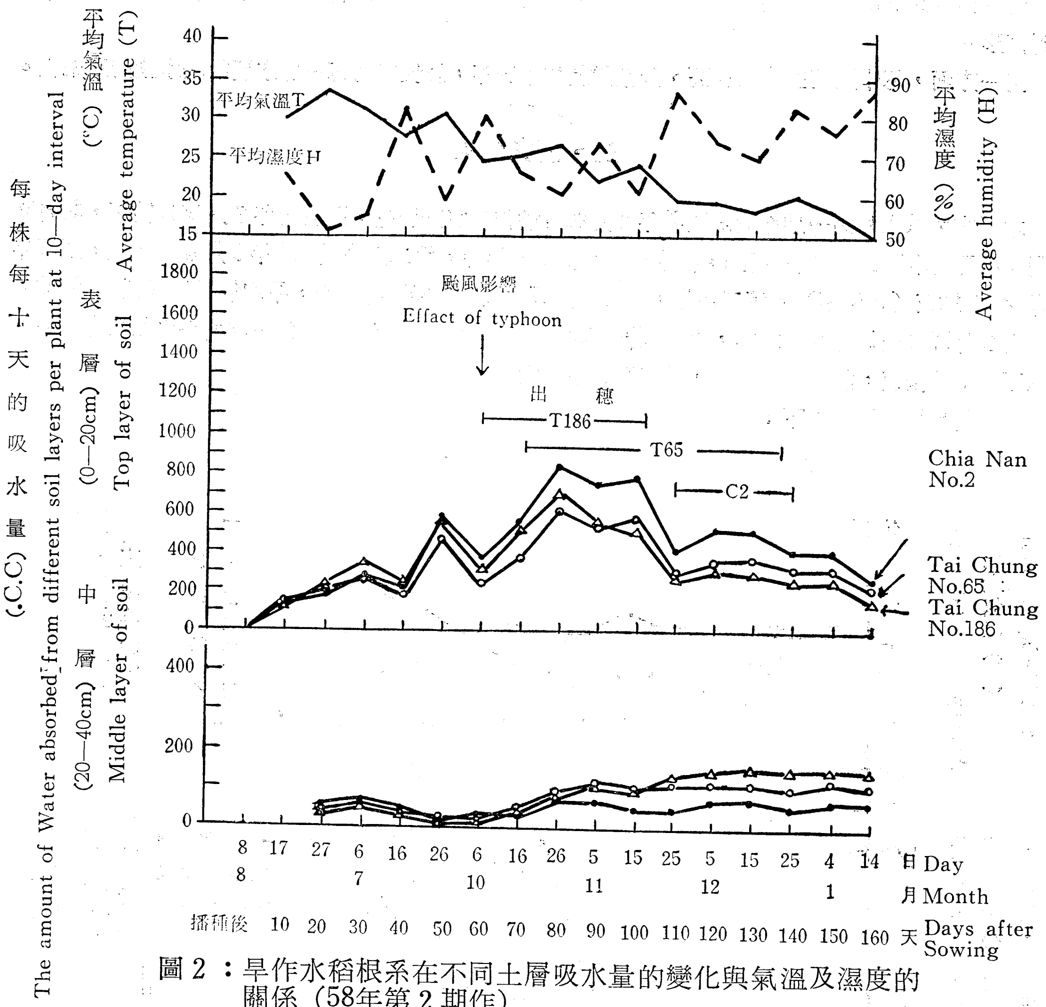


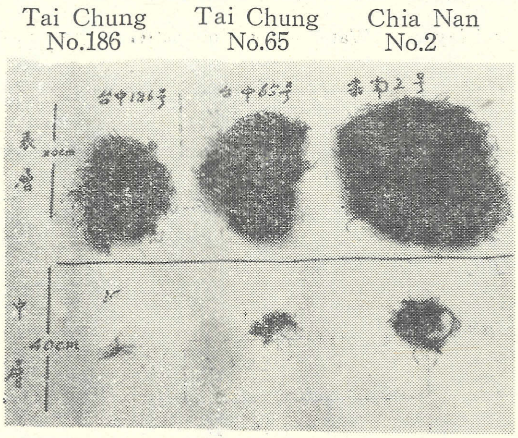
圖 2：旱作水稻根系在不同土層吸水量的變化與氣溫及濕度的關係（58年第 2 期作）

Fig.2: The water absorption of roots of lowland rice cultivated on upland from different soil layers as influenced by temperature and humidity (2nd crop, 1969)

旱作水稻根系的分佈範圍　第一期及第二期共 6 品種，根系的分佈情形，示如圖3‧4。在本研究之範圍内，第一及第二期作合計 6 個品種之稻根均未見有伸入下層（40～60cm）者。因此各圖均省去下層部份。

生育期間根系在不同土層吸水量的變化及其受氣象的影響情形　上層（0～20cm）的吸水量，從稻種發芽後隨著植株的生長而增加，至出穗期達到最高峰，然後因植株的老化而減少（如圖 1‧2）。本研究資料第一期作雖缺出穗期以後的部份，但據另以單層式自動灌水裝置研究結果（擬另文報告），如同上述。上層吸水量品種間的差異：第一期作很顯著，第二期作差異較小；晚熟種的吸水量大於早熟品種。第一期作的吸水量顯比第二期作大。此係因兩期作之間，氣象條件不同而影響水稻的發育，及第二期作後半段的溫度較低，直接影響吸水作用所致。此外應注意的是，出穗前後的吸水量受氣象因子，尤其是氣温的影響而敏感地變化。

中層（20～40cm）的吸水量：稻根未伸入中層之前，不從中層吸水。其開始吸水的時期，第一期作因温度低，水稻初期發育較慢，於播種後約30天始見吸水。第二期作在高温之下自第10天左右就



照片 2 ：旱作水稻根系的分佈情形
（9株的總根量）

The distribution of lowland rice roots cultivated on upland (total amount of 9 hills)

開始吸水。水稻生育期間中層吸水量變化的幅度，比上層小得多。上層吸水量大的品種，在中層的吸水量於出穗以後反而變小，如第一期臺農選1號及第二期嘉南2號，這點值得注意，其理由有待研究。

根系分佈型及吸水型　如圖3•4及照片2所示，分佈於上層的稻根，第一期作 92.1～97.5%，第二期作爲 98.4～99.9%（均以風乾根重表示）。稻根在中層分佈量對總根量比率的品種間差異，第一期作較大；第二期作差異很小。但是其實際發根量品種間的差異仍相當大（照片2）。

因大部份的稻根分佈於上層，故從上層吸收的水量，第一期作爲上中層總吸水量的 87.9～93.3%，第二期作爲80.1～89.8 %之高。中層的吸水量對總吸水量的百分比，以臺中 186 號來說，第二期作在高温之下大爲增高。

綜合上列試驗結果，可知旱作水稻根系從上層（0～20cm）土壤吸收大部份水量；但是中層

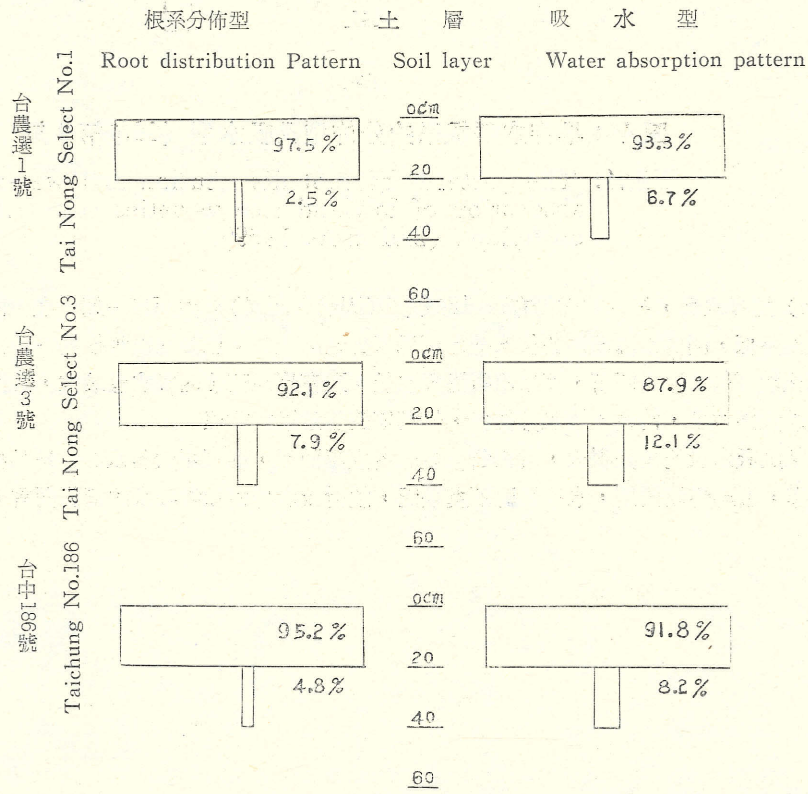


圖 3 ：旱作水稻根系的分布型及吸水型（58年第1期作）

Fig.3: The patterns of root distribution and water absorption of lowland rice cultivated on upland (1st crop, 1969)

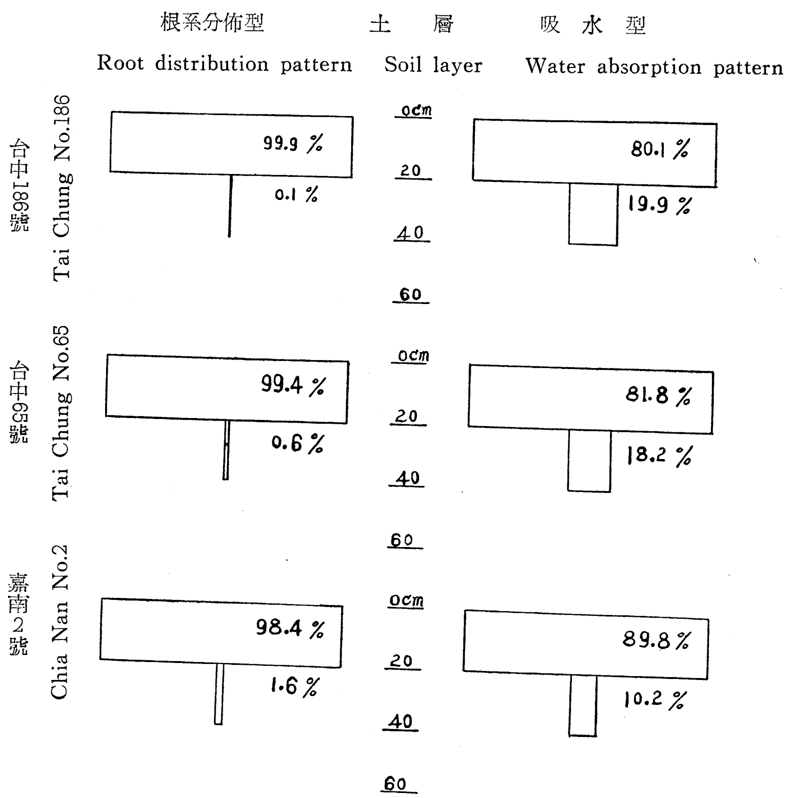


圖 4 ：旱作水稻根系的分佈型及吸水型 (58年第 2 期作)

Fig.4: The patterns of root distribution and water absorption of lowland rice varieties cultivated on upland (2nd crop, 1969)

(20～40cm) 的吸水量，第一期作仍有7～12%之多(因品種而異)。然而第一期作在中南部乃是旱季，且地下水位降低，因此當灌溉時務使水分滲至稻根伸達的土層。但是在播種後約一個月之間，只使灌溉水滲入土壤 20cm深處即可，藉以節省灌溉水量。又在出穗前後的吸水量最大，且因氣温稍微昇高，吸水量就大爲增多，消耗土壤水分甚多，特別需要注意灌溉管理。

又因品種間吸水量的差異很大，就節省灌溉水的立場而言，應採用最省水的早熟品種。

第二期作，因爲時值雨期，水的供應不虞缺乏，故對吸水特性和灌溉水的節省而言，較無問題。

STUDY ON THE WATER ABSORPTION OF LOWLAND RICE VARIETIES IN DIFFERENT SOIL LAYERS OF UPLAND (PRELIMINARY NOTE)

by

Chen-Neng Wu and Tao Lan

Summary

The study was conducted at Taiwan Agricultural Research Institute to determine the irrigation method for lowland rice varieties that cultivated on upland.

The three-layer-type auto-irrigators which can measure the amount of water absorbed by rice roots and the development of root system in different soil layers, were used in this study. The soil was divided into three layers of 0-20, 20-40 and 40-60 cm in depth. The soil moisture of every layer was controlled at the level of 75-80% of soil-water-holding-capacity. Nine hills of lowland rice for each of the three varieties in each crop season, wereplanted by direct seeding method on each auto-irrigator in the greenhouse. These auto-irrigators were covered with vinyl film so as to stop the water evaporation from their surfaces. The windows of the greenhouse were opened but covered by screens; and several air ventilators were used during day time to minimize the room temperature.

The results obtained in the first year are summarized as follows:

1. Six rice varieties tested in two crop seasons showed that there was no root penetrated into the bottom layer of the soil (40-60 cm).

2. The amount of root distributed in the top layer of the soil (0-20 cm), was 92.1-97.5 % (differed by variety) in the first crop, and 98.4-99.9% in the second crop. Accordingly, 87.9-93.3% of total amount of water absorbed by roots of a rice hill, was from the top layer of the soil in the first crop; and 80.1-89.8% in the second crop.

3. The date that rice roots began to absorb the water in the middle layer of the soil (20-40 cm), was about 30 days after sowing in first crop; then it was around 20 days earlier in the second crop than in the first crop, because the rice roots of the second crop grew faster than that of the first crop under higher temperature condition.

4. The difference of total water amount absorbed by rice roots among varieties, was highly significant, i.e. the water consumption of early maturing variety was smaller than that of late maturing variety.

5. The water absorption by rice roots in the top layer of the soil before and after heading stage changed very sensitively according to the change of temperatures.

6. Based on the above facts and for the purpose of saving irrigation water, the amount of irrigation water has to be adjusted to the level just to moisten the soil layer of 0-20 cm for about 30 days after sowing in the first crop during which is a dry season and the underground water level is very low in the Midsouth of Taiwan. After one month, however, the irrigation water has to be increased to moisten the soil layers of 40 cm deep where the rice roots have reached in this study.

On the other hand, the early maturing varieties are recommended for the upland-type culture of lowland rice in the area that short of irrigation water.

Generally speaking, the second crop is grown during the wet season in Taiwan, so there is little to be considered for the lowland rice varieties cultivated on upland with regard to the irrigation problem.